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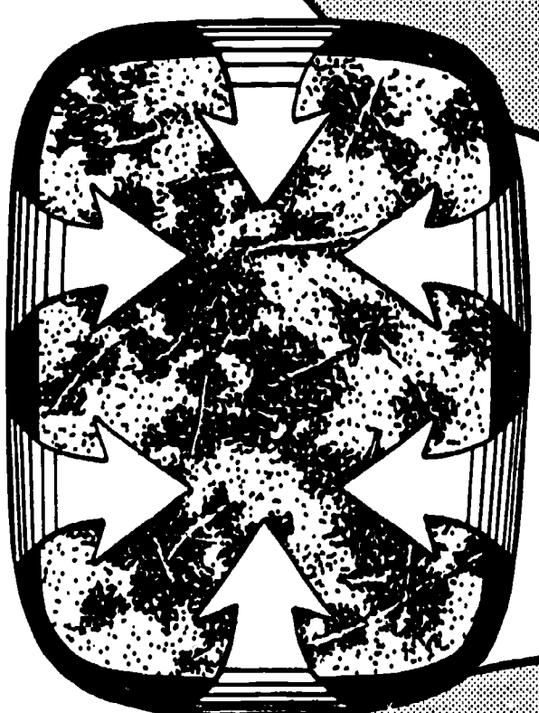
ABSTRACT

This instructor's manual contains materials needed to teach a two-lesson unit on activated bio-filters (ABF). These materials include: (1) an overview of the two lessons; (2) lesson plans; (3) lecture outlines (keyed to a set of slides designed for use with the lessons); (4) overhead transparency masters; (5) worksheets for each lesson (with answers); and (6 two copies of a final quiz (with and without answers). The first lesson (the sewage treatment plant) examines those process units that are unique to the ABF system. The lesson includes a review of the structural components of ABF system and their functions and a discussion of several operational modes and the conditions under which they might be used. The second lesson covers the operation of ABF systems. The laboratory tests recommended for influent and effluent monitoring are presented and related to the factors affecting biomass growth. Calculations regarding food-to-microorganism (F/M) ratio and mean cell residence time (MCRT) are presented and practiced. Plant observations and monitoring are discussed with an emphasis on awareness and identification of existing and potential problems. Some operational problems are also presented with recommended corrective measures. (JN)

Biological Treatment Process Control

Activated Biological Filters (ABF Towers)



Instructor's Guide

Linn-Benton Community College
Albany, Oregon
1984

BIOLOGICAL TREATMENT PROCESS CONTROL

ACTIVATED BIO-FILTERS

INSTRUCTOR'S MANUAL

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ACTIVATED BIO-FILTER

Instructor's Guide

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ABF SYSTEMS

Overview of Lessons

This unit of Activated Bio-filters can be divided into two lessons Lesson I, The Sewage Treatment Plant, covers those process units that are unique to the ABF system. In this lesson a review of the structural components of the ABF system and their functions will be covered. Since this is an intermediate course, the review might emphasize how the components relate to plant operation. Operational modes are discussed with a look at each mode and under what conditions it might be used.

Lesson II covers the operation of ABF systems. The laboratory tests recommended for influent and effluent monitoring are presented and related to the factors affecting biomass growth. Calculations regarding F/M ratios and MCRT are presented and practiced. Plant observations and monitoring are discussed with an emphasis on awareness and identification of existing and potential problems. Finally, some operational problems are presented with corrective measures recommended.

Lesson Plans

Lesson I. The Sewage Treatment Plant

- The Plant
- Unique Components
- The ABF Process
- Alternate Process Modes

* Have students read material ahead of time if possible.
* Lecture from outline with slide support.
* Add additional slides to emphasize areas of particular interest.
* Recommended length - 30 min.

Lesson II. Methods of Process Control

- F/M Ratio
- MCRT
- Bulking Sludge
- Nutrient Deficiency
- Process Monitoring

* Again, assign reading ahead of time.
* Lecture from outline with slide and overhead support.
* Assign work sheet; allow 20-30 min. to do problems; explain and correct problems.
* Return to outline and slides.
* Assign Final Test.
* Recommended length - 60-75 min.

Other Suggestions

* Demonstration items such as types of media, orifice nozzles, etc., can be used.
* Set up microscope to view organisms; have fresh sample from reactor media with organisms on display.
* Collect samples of raw, primary, reactor, and secondary effluent in jars to display characteristics.
* Have samples of trend charts for process indicator plotting.

ACTIVATED BIO-FILTERS

Lecture Outline

Lesson I - The Plant

ABF 1 & 2	Credit Slides
ABF 3	ABF Plant
ABF 4	ABF Plant
ABF 5	Unique Components - Lath media - Distribution arm - Reactor wet well
ABF 6	Fixed Film - Aerobic growth - Anaerobic growth - Sloughing
ABF 7	Suspended Growth - Short-term aeration
ABF 8	Conventional Operations - Advantages - Disadvantages

Lesson II - Process Control

ABF 3	The Process
ABF 9	Alternate Modes
ABF 10	Alternate Modes
ABF 11	Alternate Modes
ABF 12	Alternate Modes
ABF 13	Alternate Modes
ABF 14-15	Process Control F/M Ratio

ABF 16-17	Process Control MCRT
Overhead #1	F/M Ratio
Overhead #2	lbs. Food
Overhead #3	lbs. MLSS
Overhead #4	MCRT
ABF 18-19	Process Control Wasting & D.O. Control
ABF 20	Bulking Sludge & Nutrient Deficiency
ABF 21	Solids Inventory
ABF 22-25	Review

$$F = \text{LBS FOOD} = Q_{MGD} \times \text{PRI EFF BOD}_{MG/L} \times 8.34$$

$$M = \text{LBS VSS} = \text{AERATION VOL}_{MG} \times \text{MLVSS}_{MG/L} \times 8.34$$

$$M = \text{LBS MLSS} = \text{AERATION VOL}_{MG} \times \text{MLSS}_{MG/L} \times 8.34$$

$$MCRT = \frac{\text{LBS MLVSS IN AERATION BASIN}}{\text{LBS MLVSS WASTED PER DAY}}$$

$$\text{F/M RATIO} = \frac{\text{LBS FOOD/DAY}}{\text{LBS MLSS}}$$

Answers to Worksheet #1

1. The reactor wet well:

   X a. is a pumping station
   ___ b. has fixed film growth
   ___ c. collects only final effluent
   ___ d. is a settling basin

2. Increases in bacterial populations can be measured as:

   ___ a. increased flow
   ___ b. higher influent BOD
   X c. increased mixed liquor suspended solids
   ___ d. increased D.O.

3. The reactor is:

   ___ a. the area where suspended growth organisms are growing
   ___ b. essentially a settling basin
   ___ c. where the return sludge is collected
   X d. the fixed film portion of the ABF system

4. Fixed film bacteria utilize the food from:

   X a. the waste stream
   ___ b. the final effluent
   ___ c. the return sludge
   ___ d. the settling basin

5. Oxygen transfer in the ABF system is a result of:

   ___ a. air provided by a blower
   X b. splashing action
   ___ c. settling sludge
   ___ d. fluctuating flow

6. ABF mixed liquor is composed of:

_____ a. raw influent and final effluent
_____ b. fixed film organisms
_X_ c. suspended growth and sloughed fixed film organisms
_____ d. only suspended growth organisms

7. These organisms:

_____ a. must be wasted
_X_ b. absorb, oxidize and metabolize organic food
_____ c. increase the BOD in the waste stream
_____ d. are nuisance organisms

8. Material is spread over the surface of the ABF media by:

_____ a. blowers
_X_ b. fixed or rotary distribution systems
_____ c. ponding
_____ d. settling

9. An alternate process mode has the:

_X_ a. reactor effluent going directly to the secondary clarifier
_____ b. sludge all returned to the head works of the plant
_____ c. sludge wasted in total
_____ d. return sludge wasted

10. The ABF system can be operated:

_X_ a. like a high rate trickling filter followed by short term aeration
_____ b. without sludge return
_____ c. without influent BOD as food
_____ d. at 100% efficiency

11. When the ABF system is used as a roughing filter:

_____ a. sludge is not returned
_X_ b. there is no tower reactor
_____ c. the reactor wet well is by-passed
_____ d. there is no aeration in the cycle

Answers to Worksheet #2

1. F/M ratio stands for:

   ____ a. flow and management ratio
   ____ b. flow to mass ratio
   X c. food to microorganism ratio
   ____ d. force to measure ratio

2. MCRT stands for:

   X a. mean cell retention time
   ____ b. mass concentration return time
   ____ c. mixed liquor concentration return time
   ____ d. microorganism concentration respiration transport

3. In the ABF system, the F/M ratio usually is in excess of:

   ____ a. 0.1
   X b. 1.0
   ____ c. 10.0
   ____ d. 0.01

4. MCRT in the ABF system is usually:

   X a. 1.5 to 3 days
   ____ b. 15 to 30 days
   ____ c. 0.15 to 0.3 days
   ____ d. 30 to 45 days

5. Given the following data for an ABF plant calculate the F/M ratio.

   Avg. Flow = 1 MGD
   Primary Eff. BOD = 150 mg/l
   MLSS = 3,500 mg/l
   MLVSS = 2,800 mg/l
   Aeration Volume = 0.045 MG

   ____ a. 0.019
   ____ b. 0.19
   X c. 1.19
   ____ d. 2.19

6. Using the data in problem 5, calculate waste sludge volume:

____ a. 4,955 gpd
____ b. 5,955 gpd
_X_ c. 6,955 gpd
____ d. 7,955 gpd

7. Using the same data, calculate MCRT.

_X_ a. 0.26 days
____ b. 1.26 days
____ c. 2.26 days
____ d. 3.26 days

8. The normal range for the MCRT in the short-term aeration basin of an ABF system is between:

____ a. 0.15 to 0.3 days
_X_ b. 1.5 to 3.0 days
____ c. 3.0 to 4.5 days
____ d. 15 to 30 days

9. The odor of ABF mixed liquor is:

____ a. stronger than conventional A.S.
____ b. fainter than conventional A.S.
_X_ c. the same as conventional A.S.
____ d. none of the above

Final Quiz

Matching: Choose the correct answer and place an "X" in the corresponding space.

1. The reactor wet well:

_____ a. is a pumping station
_____ b. has fixed film growth
_____ c. collects only final effluent
_____ d. is a settling basin

2. Increases in bacterial populations can be measured as:

_____ a. increased flow
_____ b. higher influent BOD
_____ c. increased mixed liquor suspended solids
_____ d. increased D.O.

3. The reactor is:

_____ a. the area where suspended growth organisms are growing
_____ b. essentially a settling basin
_____ c. where the return sludge is collected
_____ d. the fixed film portion of the ABF system

4. Fixed film bacteria utilize the food from:

_____ a. the waste stream
_____ b. the final effluent
_____ c. the return sludge
_____ d. the settling basin

5. Oxygen transfer in the ABF system is a result of:

_____ a. air provided by a blower
_____ b. splashing action
_____ c. settling sludge
_____ d. fluctuating flow

6. ABF mixed liquor is composed of:

_____ a. raw influent and final effluent
_____ b. fixed film organisms
_____ c. suspended growth and sloughed fixed film organisms
_____ d. only suspended growth organisms

7. These organisms:

_____ a. must be wasted
_____ b. absorb, oxidize and metabolize organic food
_____ c. increase the BOD in the waste stream
_____ d. are nuisance organisms

8. Material is spread over the surface of the ABF media by:

_____ a. blowers
_____ b. fixed or rotary distribution systems
_____ c. ponding
_____ d. settling

9. An alternate process mode has the:

_____ a. reactor effluent going directly to the secondary clarifier
_____ b. sludge all returned to the head works of the plant
_____ c. sludge wasted in total
_____ d. return sludge wasted

10. The ABF system can be operated:

_____ a. like a high rate trickling filter followed by short term aeration
_____ b. without sludge return
_____ c. without influent BOD as food
_____ d. at 100% efficiency

11. When the ABF system is used as a roughing filter:

_____ a. sludge is not returned
_____ b. there is no tower reactor
_____ c. the reactor wet well is by-passed
_____ d. there is no aeration in the cycle

12. F/M ratio stands for:

_____ a. flow and management ratio
_____ b. flow to mass ratio
_____ c. food to microorganism ratio
_____ d. force to measure ratio

13. MCRT stands for:

_____ a. mean cell retention time
_____ b. mass concentration return time
_____ c. mixed liquor concentration return time
_____ d. microorganism concentration respiration transport

14. In the ABF system, the F/M ratio usually is in excess of:

_____ a. 0.1
_____ b. 1.0
_____ c. 10.0
_____ d. 0.01

15. MCRT in the ABF system is usually:

_____ a. 1.5 to 3 days
_____ b. 15 to 30 days
_____ c. 0.15 to 0.3 days
_____ d. 30 to 45 days

16. Given the following data for an ABF plant calculate the F/M ratio.

Avg. Flow	=	1 MGD
Primary Eff. BOD	=	130 mg/l
MLSS	=	3,000 mg/l
MLVSS	=	2,600 mg/l
Aeration Volume	=	0.05 MG

_____ a. 0.3
_____ b. 0.1
_____ c. 1.0
_____ d. 3.2

17. Using the data in problem #16 and the following, calculate waste sludge volume:

Eff TSS	=	18 mg/l
Eff VSS	=	15 mg/l
Eff BOD	=	16 mg/l
Waste Sludge Conc (%)	=	12,000 mg/l (1.2%)

_____ a. 817 gpd
_____ b. 5,600 gpd
_____ c. 7,453 gpd
_____ d. 9,207 gpd

18. Using the same data, calculate MCRT.

_____ a. 0.26 days
_____ b. 1.2 days
_____ c. 2.26 days
_____ d. 3.26 days

19. The normal range for the MCRT in the short-term aeration basin of an ABF system is between:

_____ a. 0.15 to 0.3 days
_____ b. 1.5 to 3.0 days
_____ c. 3.0 to 4.5 days
_____ d. 15 to 30 days

20. The odor of ABF mixed liquor is:

_____ a. stronger than conventional A.S.
_____ b. fainter than conventional A.S.
_____ c. the same as conventional A.S.
_____ d. none of the above

ACTIVATED BIO-FILTER
(ABF)

Answers to Final Quiz

Matching: Choose the correct answer and place an "X" in the corresponding space.

1. The reactor wet well:

   X a. is a pumping station
   ___ b. has fixed film growth
   ___ c. collects only final effluent
   ___ d. is a settling basin

2. Increases in bacterial populations can be measured as:

   ___ a. increased flow
   ___ b. higher influent BOD
   X c. increased mixed liquor suspended solids
   ___ d. increased D.O.

3. The reactor is:

   ___ a. the area where suspended growth organisms are growing
   ___ b. essentially a settling basin
   ___ c. where the return sludge is collected
   X d. the fixed film portion of the ABF system

4. Fixed film bacteria utilize the food from:

   X a. the waste stream
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Aeration Volume	=	0.05 MG

_____ a. 0.3
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__X__ c. 1.0
_____ d. 3.2

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